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ABSTRACT

This paper presents experiences introducing computers and the Internet to stimulate cooperative work and improve the way students learn chemical engineering. (Author/WRM)

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# ENGINNERING EDUCATION USING TECHNOLOGICAL RESOURCES:
## The experience of Chemical Engineering Department at PUCRS

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***Abstract*** *- This paper will describe the experience of introducing technological resources in the Chemical Engineering Department at PUCRS. The project includes the survey on the needs, the creation of laboratories and activities to create a group of lectures involved in the process. The main contribution of this paper is the description of the steps of the project, since its conception until the presentation of the first prototype. Many issues will be addressed such as the integration of the groups, how to involve the faculty, pedagogical aspects as well as the prototype and its use (experience, results, contributions).*

### Introduction

During many years, the main discussion related to the use of computers in the educational process was focused in the problem of lacking of equipment. Nowadays, many other challenges can be found. One of the most important challenges is how technological resources can be used in the educational process to increase its quality rather than just to introduce a new resource. Resources such as Internet and Multimedia Catalogues bring some different possibilities to the students. Once they are in the information era, there is a continuous search for new information.

However, to use technological information in the educational process requires a filter to select what is really useful. It does not matter *how much*, but *which* information is available. It is the dilemma *quality* or *quantity*. One characteristic that can contribute in the process of filtering information is *criticism*. Teachers and students together can do the process of deciding what *is* or what *is not* important.

After some discussions, we can summarize the question and the answer for the previous problem in two words: collaborative work.

One of the experiences was the WEQ-Net project that proposes the use of Internet in chemical engineering courses. The project started with the integration of two distinct groups, Chemical Engineering Department and Computer Science Department (called Instituto de Informática), to design and implement a Web site that covers many subjects related to chemical engineering. The WEQ-Net model, created to be the structure of the site, contains three modules: theory, educational and collaboration. The first prototype available (CODE-Web, finished in 1997) is related with synthesis of distillation columns.

This paper will describe the experience of introducing technological resources in the Chemical Engineering Department at PUCRS. The project includes the survey on the needs, the creation of laboratories and activities to create a group of lectures involved in the process.

### Some Discussions and Related Work

The use of the Internet as a tool to help the educational process has been widely encouraged by schools and universities. The main objective is to modify the process of *teaching* in to a process of *learning*. There are many experiments in distance education, including undergraduate, post-graduate and extension courses where the student is stimulated to be more independent (*teaching* x *learning*). To achieve good results in this kind of project, it is necessary to congregate efforts from different professionals in order to create a proper environment.

The use of computers in education is not a new idea. The first ideas and experiments come from the 40ties [14] and in Brazil, these ideas come from the 60ties and in the past 10 years they have highly developed. Many groups of researchers have taken care of special requirements in this wide area such as educational software development, human resource development, artificial intelligence issues and others.

In the past few years, many groups have been developing some research in the use of network resources (specially the Internet) in education. Some examples are: KUCHINSKI [11], HOBBS e TAYLOR [10], MARTINS e PINTO [12], PGIE [16]. The concept of Virtual University has been used and the idea of distance education has changed due to new technological resources.

Some other experiences using computers and Internet in education are:

- structural subject in civil engineering [9];
- Open University / United Kingdom [15];
- development of educational environments [19];
- development of hypermedia editors to improve the design of educational sites [12];
- *on line* tutorials [20];
- use of WebChat [5];
- use of Internet in undergraduate courses [17];
- tools to improve the learning skills [18].

Based on the idea of using technological resources in education and the previous work done by CARNEIRO [7], we developed a model to structure



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collaborative work through the Internet among students of the Chemical Engineering course at PUCRS.

The Chemical Engineering Department at PUCRS has a good history on introducing computers in undergraduate and post-graduate courses to improve the quality of education. There is a network connecting some labs, creating a proper infrastructure for students. Since many changes have been introduced, there are some projects being developed in order to investigate all the implications and the requirements in the use of computers and in education.

One of these projects is *WEQ-Net* - Collaborative Work in Chemical Engineering Course that intends to use collaborative work based on the Internet. The main idea is to design and develop a WEB-based environment with three basis: theory, experimental and collaboration, that covers different chemical engineering subjects depending on the structure of the courses. The result of this is an environment to help students in many skills related to chemical engineering.

The first subject to attempt experimented in the WEQ-Net structure was Unit Operations linked with the course Unit Operations of Chemical Industry. This course is available to students in their 4th year of study and it involves the design of gas absorption, distillation and extraction columns. The traditional way of learning these contents is to solve problems using graphs and tables. The effect of this is a not-well profit class.

The structure of the first experiment is the following:

- a theory module with concepts related to Process Separation, Distillation, Extraction and Gas Absorption;
- an experimental module with the implementation of SINCO software [7] to the Web structure;
- an collaboration module with the requirements to create groups of people (students and lecturers) to render does a collaborative work.

By using this model it is possible to work in a distance education perspective, as well as a collaborative work perspective. This is possible because the system provides some ways of recording and accessing the assignments of the students that can be viewed by students (limited view) and supervisor (teacher, lecturer or professor) that can propose new exercises.

## Chemical Engineering Laboratories Infra-Structure

Since 1996, the Chemical Engineering Department has available one special laboratory, called LASP (Process Simulation Laboratory), built using resources from two Brazilian agencies to stimulate research projects: PADCT (Programa de Apoio ao Desenvolvimento da Ciência e Tecnologia - CAPES) and FAPERGS (Fundação de Apoio à Pesquisa do Rio Grande do Sul).

The laboratory was structured to maintain many different spaces including a classroom, a meeting room, and an office to the secretary, an office to the supervisor of the project and laboratory. To complete the structure, some simulators related to Process Design were installed in the network such as *HYSIM* (Hyprotech), *Pro-II* e *Hextran* (Simulation Science) and *Super Pro Designer* (Intelligen).

## WEQ-Net Project

The WEQ-Net - Collaborative Work in Chemical Engineering Course project deals with the design and development of a WEB-based environment.

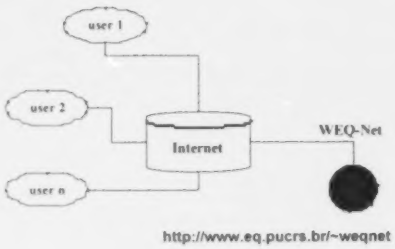


*Figure 1. System Utilization*

The first prototype was developed by BOFF et al [4] and the subject was Unit Operations. It is possible to access this prototype, called CODE WEB, at the following URL **Error! Bookmark not defined.**. Some modifications were made and the new version is available at the following URL: **Error! Bookmark not defined.**.

Figure 1 shows how the system works. The modular structure of the WEQ-Net is showing in figure 2 (in a linear form, without showing the hypertext idea).

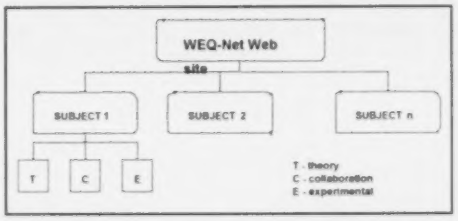


*Figure 1. WEQ-Net system linear structure*

### Theory Module

The theory module contains the concepts related to chemical engineering to act as a complementary tool for the classes. It includes some


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references to Internet sites that deal about the referred subject.

Its implementation is in a hypertext format, according to the model used in WWW. Resources like HTML, images, text, forms, CGI and databases were used. This module has set of complementary information to the study or research.

**Collaboration Module**

The main objective of the module is to support collaborative work, with an environment for supervised study, managed by a supervisor. The module deals with *groups* that are constituted by a supervisor (the group creator) and some students. A group is created by the webmaster (denomination of the coordinator of a web site) and it is possible to create groups of professors, lectures and students for local courses at PUCRS or remote courses. Groups can be *closed* or *open*. In a closed group, the supervisor includes the members and it is not possible to join the group without requesting the inclusion to the supervisor. In other way, a supervisor creates an open group but anyone can join the group. The only restriction is the maximum number of members in the group.

This module includes some features for creating, submitting and correcting exercises. Also, the supervisor is able to answer any question using e-mail or chat windows. The most important issue in this module is the ability to observe and supervise the rhythm of each student, respecting individual restrictions.

**Experimental Module**

This module involves the development of software tools related with the theory module. They support simulation, synthesis and several other processes related with chemical engineering. The first tool available is the SINCO synthesizer [7] that aids the distillation column design. This software was adapted to the Internet environment [6].

In this module, the students can apply their theoretical knowledge in a practical way. They can use the SINCO synthesizer to design a distillation column using a Web page as the interface. There are some forms to input the data and the result is a report that describes the specifications of a column, like diameter, height, reflux ratio and operation conditions. The result can be stored to allow the observation by the lecturer.

## A Practical Experience using WEQ-Net

One practical experience started in 1996 with a severe change in *Operações Unitárias da Indústria Química* III course development. This course was 6 hours per week and it was divided in 4 hours to theoretical content and 2 hours in a practical laboratory (LASP lab). The first approach was to introduce a practical view in 2 hours (laboratory), using spreadsheets to improve the design and development of columns, Internet to improve the research tasks and electronic mail to establish another way of communication between students and lecturer [8].

Some changes in students behavior were observed such as an improvement of their ability in using computers, starting point to cooperative work and a more involvement of from the students in homework and research tasks. As a negative point, it was possible to observe that some students did not want to use the computer and it took some time to stimulate them to use it.

After analyzing the previous experience, some modifications were proposed. The first change was the introduction of some extra-class modules to teach how to use the computer (hardware, software and network). Other changes can be viewed as structural changes and improvements, such as the introduction of commercial simulators to help solving their assignments. Therefore, the students can compare their procedures (based on simplified equations) to those generated by commercial software (that use accurate solutions).

The second approach was the design and development of WEQ-Net system. This learning environment allows the students to use the SINCO synthesizer that is an initial view if compared with commercial simulators. Usually, the simulators are specific to some subject and they should be used as a complementary tool to enforce the theoretical concepts presented in another learning paradigm [2] [13].

Another feature available in the WEQ-Net system is the use of chat systems to stimulate the interaction between students from the same group or different groups. One practical experience including different groups is already arranged between the group from PUCRS and one group from the Chemical Engineering Course at Universidade Federal do Paraná (UFPR). In the first meeting the students will talk about different subjects and after acquiring some experience, they will have specific subject to debate. All the meetings will be recorded to have some way of analyzing and having some feedback.

## Results and Some Considerations

An important step in such project is the observation and evaluation of the results. During the previous steps of the project many records were created to keep a history of the facts. It was expected that the introduction of new ways to improve the learning process could cause some difficulties or stress. But it is important to say that most of the students were open to learn different subjects such as Internet, Spreadsheets, and basic concepts of computing besides the specific subject of the course.

A formal observation in the laboratory could show that the period of time that students stayed in the laboratory was over any previous observation. Moreover, two hours of the course were dedicated to stay in lab. The implementation of some studies such



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as KIRKPATRICK (in BALESTRI [1]) helped in the process of keeping the class running in a computing laboratory with minimum stress.

It is important to keep in mind that some technical/administrative problems can occur in a laboratory and some experience can improve the way the lecturer can cope with the problem. The most frequent occurred problems were: the printers have problem, the students did not find their files in the floppy disk, hard disk or network disk, error messages without much information and so on. It is important to notice that this kind of problem is reduced if the students work with other students (groups).

Some perceptions could also be observed. Computers are like fascinating "objects" to some students. Sometime this is a good point, but sometimes it can destroy the purpose of proposal for a laboratory class. The lecturer should be very confident about the work to be done and how to conduct the class to avoid problems.

As a final comment, we can say that the result is really positive and it is very important to make formal observations with specific aims to have a feedback of the proposed change. Our formal observations dealt with about the behavior of the students before and after the introduction of the computers and Internet.

## Final Considerations

This paper presented some experiences in introducing computers and Internet to stimulate cooperative work and improve the way students learn specific subjects. Our first experience was extremely productive and we could observe that the interaction between students and the lecturer was increased in quality and quantity as well as the interaction among students.

Related to the proposed model, we could observe that is a complete overview of the student's needs. It comprises research, practical exercises, cooperative and collaborative work and the perspective of using new technologies.

The project is being reviewed based on the results of the first six months of use. Some difficulties were identified and are under studies to became part of the project:

- assessment module to be part of the assessment project at PUCRS (this project is conducted by a group in charge of identifying the quality of the professors, lecturers and university infra-structure);
- improvement in the exercises option in educational module;
- improvement in the cooperative environment including video-conferencing systems and videos.

One last consideration is relevant to this context. The computer is not the only way to improve quality of learning/teaching. As said by BELHOT [3], "The computer is not a substitute to the professor, but a resource to improve teaching activity".

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